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Coast Steamship Company, for half-rates over their lines. In fact, it were better to thank every person with whom I came in contact, for without exception I was helped by everybody that could help me. I wish to express my appreciation of the kindness received from Judge HART and his nephews, WILLIAM and H. B. HART, of Union Point, and to thank Mr. LITTLE, Mr. ROSSMAN, and many others of Greensboro for their splendid hospitality. My stay in the Sunny South was made so pleasant that the name of Georgia is synonymous with friendship, hospitality, and good-will.

The following assistants have placed me under obligations and aided science: J. T. BRYSON, D. A. SAGGUS, J. M. SAGGUS, H. H. ANDREWS, A. S. ONEAL, W. J. ONEAL, E. J. STANLEY, JNO. T. BOSWELL, CLAY FILLINGHIM, all of Siloam; and Mrs. ROBINSON, of Greenboro, who made drawings of the corona.

Finally, I must not forget "Colonel Mustapha" Berry Evans, the colored wag of the village, who carries the mail from the post-office to the station four times a day for less than three dollars a month, but manages to make his living with less work than any man in the neighborhood. He was my helper throughout. There is a smile in the story of how he would have assisted me more if I had applied to him in time. I was making sextant observations for position one night, and this aroused his curiosity. In answer to his question of what I was doing, I told him I was trying to find out exactly where I was. His amazement and pity for my ignorance found expression in "Foh de Lawd's sake! why did n't you ask me? I was done bo'n and brought up heah! You 's *right heah in Siloam.* I reckon you 's foolin' me!"

CHABOT OBSERVATORY, OAKLAND, CAL., September, 1900.

THE CROCKER EXPEDITION TO OBSERVE THE TOTAL SOLAR ECLIPSE OF MAY 28, 1900.

BY W. W. CAMPBELL AND C. D. PERRINE.

The generosity of WILLIAM H. CROCKER,[*] of San Francisco, enabled the Lick Observatory to send an expedition to observe the total solar eclipse of May 28, 1900. The organization of the expedition was begun by Professor KEELER, Director of the Observatory, at the middle of March. The members of the staff detailed for this duty were the writers of this article. The preparations of the instruments and equipment were necessarily very hurried, but Professor KEELER placed the resources of the Observatory at our disposal, and the heavy packages were ready for shipment on April 11th. However, several new prisms and lenses ordered from the Eastern makers arrived so late that the three new spectrographs could not be completed before the shipment was made. They were finished at the station, only a day or two before the eclipse. The observers left San Francisco on April 24th, via El Paso and New Orleans.

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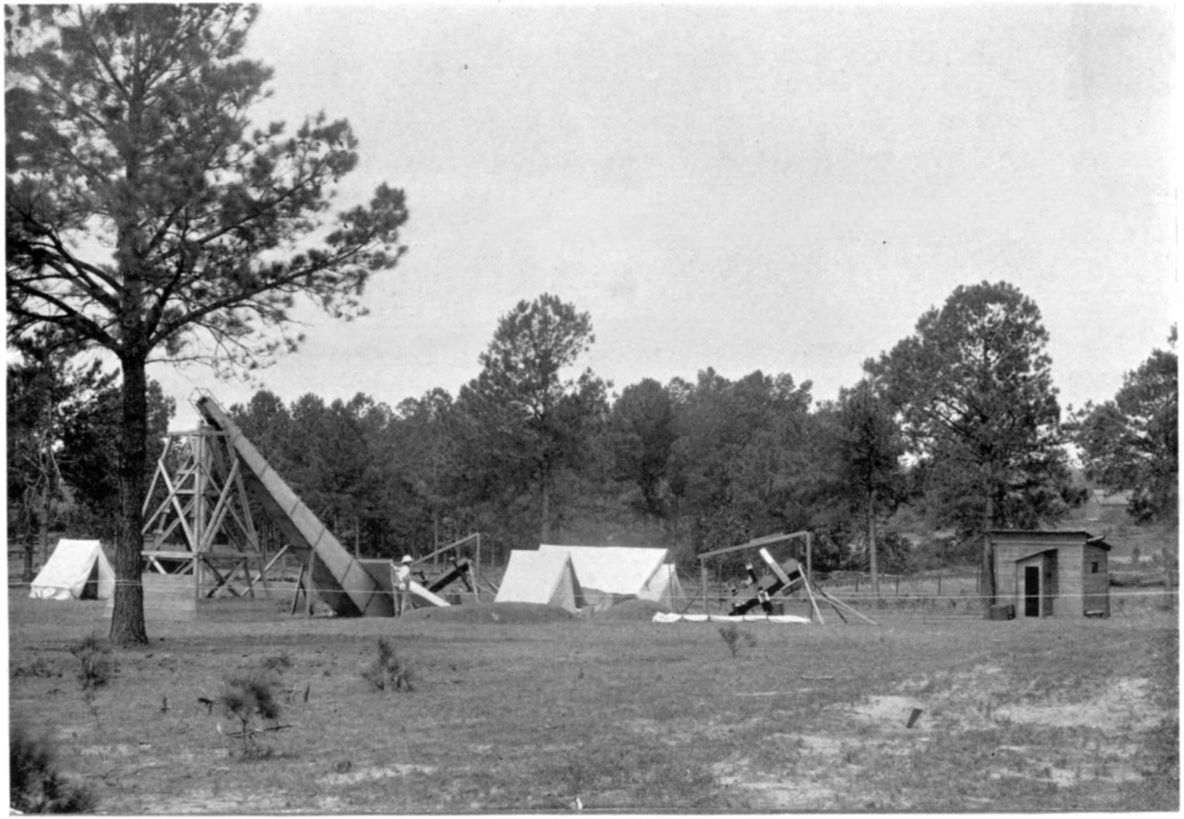
[*] Mr. CROCKER's brother, the late Colonel C. F. CROCKER, Regent of the University of California, had similarly befriended the Lick Observatory, in the Expeditions sent to Cayenne in 1889, to Japan in 1896, and to India in 1897–98.

The path of totality began at sunrise in the Pacific Ocean, swept across Mexico, the southeastern portion of the United States, the Atlantic Ocean, Portugal, Spain, and Algiers, and ended at sunset in southeastern Egypt. Observations in the elevated regions of Mexico were precluded by the low altitude of the Sun; and the path available in the United States for occupation by an observing party lay along the line joining New Orleans, Louisiana, and Norfolk, Virginia. The cloud observations secured in May and June of the three preceding years by the Weather Bureau, indicated that the chances for clear sky were best in eastern Alabama and western Georgia, where the foothills of the mountains reach nearly to the shadow-belt, and where the height of the station above sea-level would be the greatest. Stations to the east of this locality would have the compensating advantage of a higher Sun. As the eastern observatory parties would probably select stations well to the east, it was decided that our party should locate in western Georgia, at the city of Thomaston.

The observers reached Thomaston on the evening of April 30th, and were warmly welcomed by the Mayor, the County School Commissioner, and other prominent citizens. The next forenoon, in company with these gentlemen, we were driven over the surrounding country — beautiful rolling country, grown over with forests of pine and oak, or just sown with cotton-seed — in search of a suitable camp. A site was selected in an open field, gently sloping to the west, about one half mile northwest of the city, but still within the city limits.

The preparation of the camp began at once. Relegating the carpentry, masonry, and excavating as far as possible to local



GENERAL VIEW OF THE OBSERVING-STATION OF THE CROCKER ECLIPSE EXPEDITION,
THOMASTON, GEORGIA.

workmen, our own time was very fully occupied, up to the last minute, with completing, mounting, and adjusting the instruments, and in training the assistants to the programme of observations.

The 40-foot photographic telescope was mounted almost precisely as it was mounted in India in 1898. A wooden tower, pyramidal in form, was constructed to support the 5-inch lens. A larger tower of the same form surrounded the lens-tower, so that, when covered with canvas on the morning of the eclipse, the wind could not vibrate the inner tower and the lens. The outer tower also supported the upper end of the canvas tube of the camera. The lower end of the canvas tube, the steel track for the traveling plate-holder, and the clock were in a pit excavated in the red clay soil to a depth of about nine feet. A large canvas sheet covered the pit and its approaches, to keep the rain from entering it.

The four spectroscopes and one medium-sized camera were mounted on a large polar axis, driven by a clock placed at the end of a sector 10½ feet in length.

Two medium-sized photographic telescopes and four small cameras were mounted on another polar axis, driven by a clock at the end of an 8½-foot sector.

Brick piers extending to a depth of two feet were constructed to support the polar axis; and similar piers served to support the chronometer and the sextant basin of mercury. The soil under the camp transmitted vibrations with but little loss of strength. It was impossible to make sextant reflection observations if any person was walking within twenty-five or thirty yards of the observer.

A very complete dark room, six by ten feet, with water-pipes for supply and waste, was constructed.

Sextant observations of the Sun and of the stars, for determining the latitude and longitude of the camp, were secured soon after our arrival. Thomaston is situated at the end of a branch line of the Central of Georgia Railway; and the regular time-signals do not go over this branch. At our request, the officials of the Western Union Telegraph Company transmitted the signals of the U. S. Naval Observatory clock in Washington daily to Thomaston, for comparison with our local time. As a result of six days' observations, and telegraphic comparisons, the longitude of the station was found to be

$$5^h\ 37^m\ 18^s.8 = 84^\circ\ 19'.7.$$

The observed value of the latitude is + 32° 53'.7.

These values are approximate, since the final reductions have not been completed. The station was one half a mile northwest of the central line assigned by the American Ephemeris, and very close to the British Almanac line.

As in other recent expeditions sent out from here, dependence was placed on volunteer observers to take the greater number of the photographs. Seven astronomers from a distance volunteered to serve, at their own expense, and seven additional assistants from Thomaston offered their services. These gentlemen were: Professor Dr. A. A. NYLAND, Director of the Utrecht Observatory, Utrecht, Holland; Dr. J. H. WILTERDINK, Astronomer in the Royal Observatory, Leiden, Holland; HEBER D. CURTIS, Professor of Mathematics and Astronomy in the University of the Pacific, San José, Cal., and now Fellow in Astronomy in the University of Virginia; JOHN A. MILLER, Professor of Astronomy in the University of Indiana; W. P. RUSSELL, Professor of Astronomy in Lincoln University, Lincoln, Illinois; A. H. BUCHANAN, Professor of Mathematics and Astronomy in Cumberland University, Lebanon, Tenn.; G. E. LUMSDEN, Esquire, President of the Toronto Astronomical and Physical Society; Captain J. R. ATWATER, Mayor of Thomaston; Dr. EUGENE T. BOOTH, of Thomaston; Professor REMBERT G. SMITH, President of the R. E. Lee Institute, Thomaston; Professor GEORGE K. ORR, of the Lee Institute; Professor JOSEPH E. HANNAH, Col. JOHN H. LEWIS, and ALBERT A. MATTHEWS, Esquire, of Thomaston.

We wish to acknowledge very fully the able and faithful services rendered to the expedition by these assistants. They multiplied the quantity of useful results obtainable several fold.

The assistants were drilled on the three days preceding the 28th, until every man felt confident that he could carry out his share of the programme, in the eighty-five seconds of totality. The delicate parts of all the instruments were examined, and all the adjustments were tested, so far as possible, on the day before the eclipse. The Weather Bureau predicted unusually favorable atmospheric conditions for the eventful morning along the entire line of totality. The night of the 27th was devoted to "backing" the plates and filling the plate-holders, and the sky was beautifully clear, at least up to 3:00 A.M. On rising for the day's work, at 4:00 A.M., the sky was completely clouded!

The clouds were gradually dispelled by the heat of the Sun, until at the time of first contact, the sky was nearly clear. Sextant observations for time were secured, and reduced; and, a light breeze springing up, the wind-screens were placed on the tower, and on the windward side of each polar axis. Five or ten minutes before totality the instruments were directed to the Sun and the clocks started, and the assistants took their places. Attention was called to the large masses of clouds rapidly approaching from the southwest. Up to two or three minutes before totality, it seemed certain that the corona would be completely hidden; and up to one minute thin clouds threatened to cut off portions of it. Fortunately, there was time to secure the observations; and about one minute after totality the clouds obscured the Sun. The state of the air had been such that the lowering of its temperature as the eclipse came on was sufficient to form clouds. In another half-hour these had disappeared; and a second set of time observations were secured just after the last contact. The sky throughout the morning was quite white.

The programme of observation, with the eleven instruments, and by two visual observers, was completely carried out, except that on one of the spectroscopes a clock for giving uniform motion to the plate-holder refused to work just at the beginning of totality. However, it was quickly righted, and the desired long exposure to the corona spectrum during totality, and the exposure with moving plate-holder at the end of totality, were secured; so that only one-third of the work with this instrument was lost.

Owing to the great distance from the Lick Observatory, we could not follow the practice of the Eastern parties in taking the plates home for development in cool dark-rooms. It was necessary to develop at Thomaston. The week following the eclipse was very hot, both day and night. The dark-room was uninhabitable by day; but after ten o'clock at night, by the liberal use of ice, the temperature of the room could be brought down to between seventy and seventy-five degrees ; and the development was carried on between that hour and daylight.

As a result of this expedition, the Observatory possesses a large number of very beautiful and very valuable photographs of the eclipse phenomena, as well as several valuable results obtained from the visual observations.

The ninetieth-meridian times of beginning and ending of the total phase for the position of the station, as computed from the

American Ephemeris data by Messrs. PERRINE and CURTIS, were—

for beginning, May 28th, $7^h\ 38^m\ 17^s.3$ A.M.
for ending, $7\ \ 39\ \ 42.2$ A.M.

The computed duration was $1^m\ 24^s.9$.

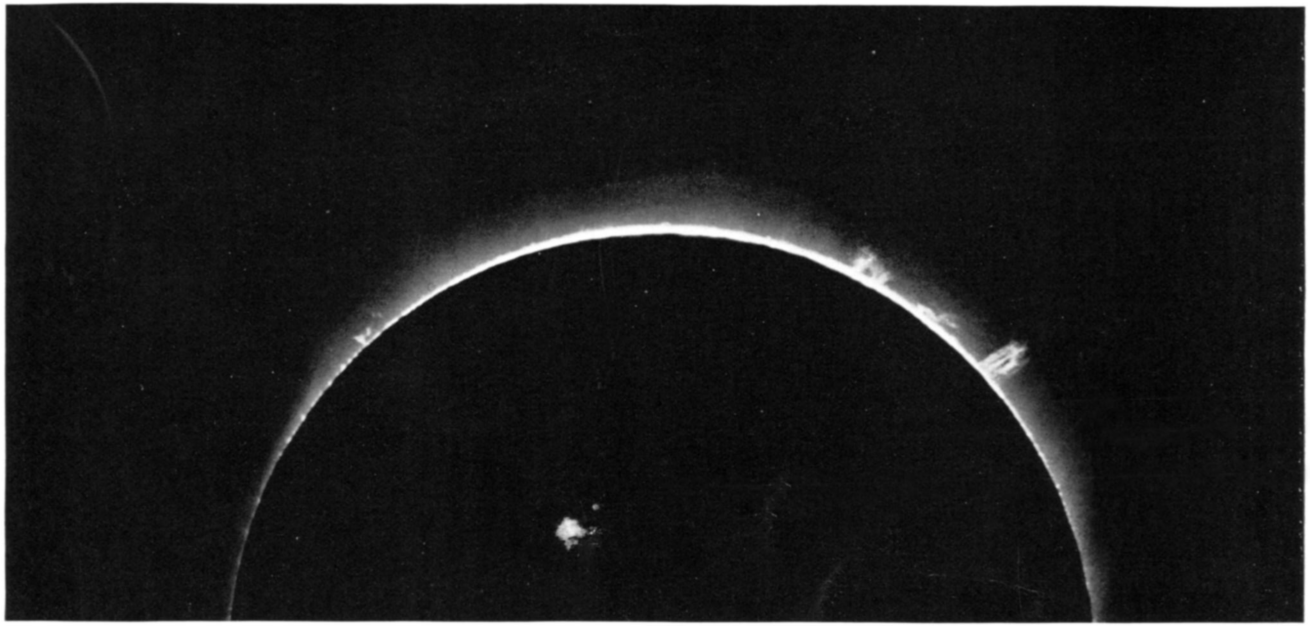
The duration as observed by Mr. PERRINE, in the camera-end of the 40-foot telescope, was $1^m\ 23^s.7$; and by the naked-eye observers it was certainly more than $1^m\ 25^s$, and may have been as much as $1^m\ 27^s$. The signal "Go" was given by Mr. PERRINE, at the instant of totality, as a signal to the man at the chronometer to begin the counting of seconds aloud, as a guide to the observers. The signal did not refer to the instant when the crescent of light disappeared, but to an instant—possibly one and a half seconds later—when the last points of light, shining evidently through the depressions in the Moon's edge, vanished completely. At the end of totality, the first points of returning light were visible to Mr. PERRINE after a duration of $1^m\ 23^s.7$. To two naked-eye observers—Messrs. CURTIS and RUSSELL, detailed for this purpose—the light, probably the crescent of sunlight, returned at $1^m\ 25^s.3$ after the signal "Go." It is probable, therefore, that the interval between the disappearing and reappearing crescents was about $1^m\ 27^s$. At any rate, it is certain that the signal given by Mr. PERRINE, for the disappearing points of light, was perceptibly later than the instant when, to the naked eye, the eclipse seemed to be total.

The times of beginning and ending noted by Mr. PERRINE were—

$7^h\ 38^m\ 10^s.1$ A.M.
$7\ \ 39\ \ 33.8$.

The total phase, therefore, occurred between seven and eight seconds earlier than the time assigned by the Ephemeris.

Eight photographs were secured with the 40-foot telescope during totality, on Seed's No. 27 plates, single-coated and "backed," with exposures varying from half a second to sixteen seconds. They are of great excellence. The structure of the prominences, the thick chromospheric stratum, and the coronal streamers are beautifully shown. The hoods of streamers inclosing the prominences, so remarkable a feature on the Indian coronal photographs of 1898, are not conspicuous on the present photographs, though certainly present in the case of one prominence of medium size. There are several minor indications of a connection between



THE PROMINENCES, CHROMOSPHERIC LAYER AND EXTREME INNER CORONA, ON THE WEST SIDE OF THE SUN.

(Exposure One-Half Second, Near the End of Totality.)

CROCKER ECLIPSE EXPEDITION, THOMASTON, GEORGIA.

the prominences and the streamers; but further evidence must be secured at future eclipses, before the question will approach solution.

A number of fine small-scale photographs of the corona were obtained with the shorter telescopes, suitable for studying the details and forms of the streamers in the regions of medium brightness.

Several of the shorter cameras were devoted to a determination of the conditions best adapted to recording the faint outer streamers of the corona. Several varieties of plates — single and triple coated, slow, medium, and rapid — and exposures from short to very long, were tried. It had seemed to us that the question of recording the outer extensions was one of contrast; and that slow plates, with normal exposure and full development, would give the best promise of success. The results justified this conclusion. The greatest extensions, about four solar diameters on the west side, were secured with a camera whose ratio of aperture to focus was 1 to 3½, and an exposure of twenty seconds on a lantern-slide plate. The inner corona, as was expected, was very much over-exposed. Visual observations of the corona by Messrs. LUMSDEN, BUCHANAN, CURTIS, MILLER, and HANNAH agreed very well in placing the lengths of the visible streamers on the west at about 3 or 3½ diameters, and somewhat shorter than this on the east.

The objective-prism spectrograph, with two 60° prisms in front of a 2-inch aperture and 60-inch focus objective, furnished a fine photograph of the bright- and dark-line spectra of the Sun's edge at the end of totality, as the edge was gradually uncovered by the Moon. This is on a plate moved by the clock which refused to run at the beginning of totality, referred to above. This plate, limited in size by the construction of the instrument, extends from a little below the *b* group to a little above *K*. It contains about 600 bright lines, sharply in focus, as well as the dark-line spectrum to which the bright lines gave way as the Sun reappeared. It is about six inches in length.

A 20-second exposure on the spectrum of the corona, with the same instrument, records the prominences in their principal chemical elements, as well as the two coronal rings at $\lambda\lambda$ 369 and 423.

The structure of the green coronal ring, on the west side of the Sun, as recorded by an objective grating spectrograph, agrees, in general, with that of the ring as photographed with the same instrument in India. The coronal material radiating the green light is heaped up in the sun-spot regions very markedly. The position of the ring is λ 5303±, as determined from the Indian plates. The eastern half of the ring was not recorded.

A photograph of the spectrum of the inner corona, taken with a slit spectroscope, is free from dark lines, as in the case of the Indian photographs.

Very interesting and successful observations of the shadow bands were made at the beginning and ending of totality by Messrs. BUCHANAN and LUMSDEN. White sheets were stretched on the ground, on which the bands were well observed. The directions of the bands were fixed by placing long rods of wood on the sheets, and adjusting them, during the second of time that the bands lasted, to the proper direction. The positions of the rods were afterwards determined to be:—

For the beginning,	N. 37° W.,	by Professor BUCHANAN.
For the ending,	N. 42° W.,	by Professor BUCHANAN.
For the ending,	N. 39° W.,	by Mr. LUMSDEN.

The bands were traveling toward the northeast. These gentlemen also secured very satisfactory drawings of the outlines of the corona.

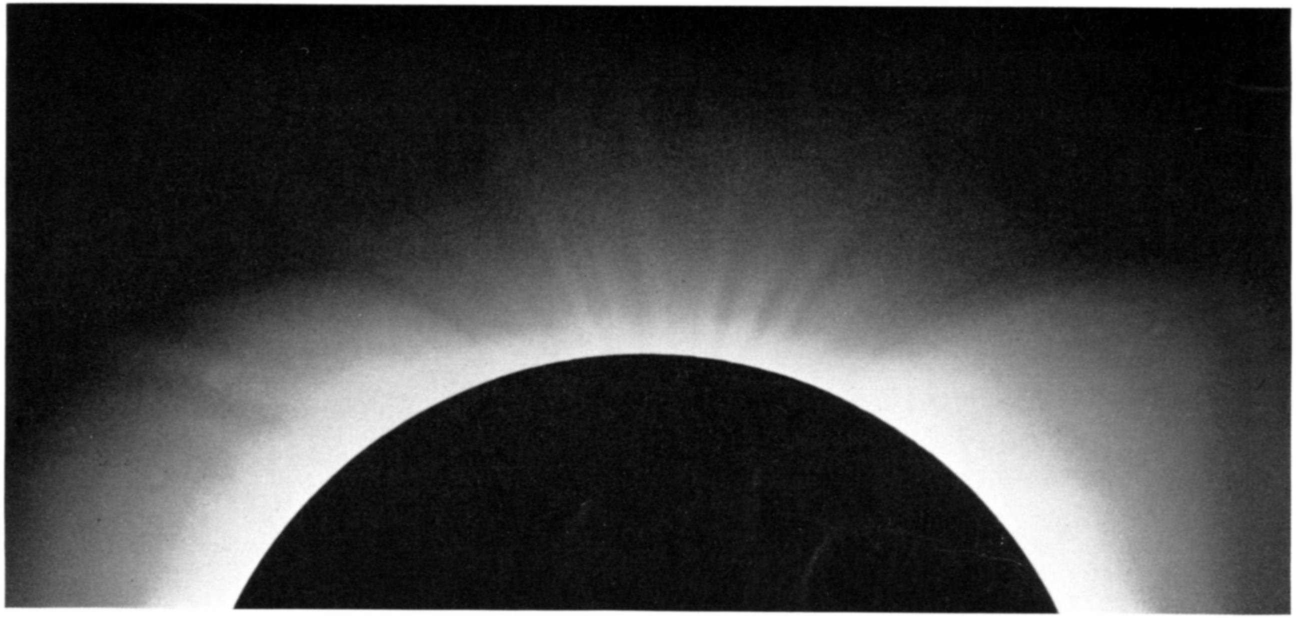
The sky seemed slightly brighter during totality than at the Indian eclipse. There would have been no difficulty in reading ordinary print.

Portions of two of the large-scale photographs of the corona are reproduced to accompany this article. It should be said that the finer details of the photographs are almost entirely lost in the process of reproduction. There appears to be no known way in which such pictures can be satisfactorily copied by mechanical processes.

It will be understood that the foregoing account of the work of the expedition is of a general nature. The detailed study of the photographs and of the individual observations will be made as soon as possible, and the scientific results will be published later.

The expedition received valued favors from many sources, which we gratefully acknowledge.

The Southern Pacific Railway Company assisted the expedition in every possible manner. We are especially indebted to General Passenger Agent T. H. GOODMAN; General Freight Agent WM. SPROULE; the officials of the freight offices in San



THE NORTH POLAR STREAMERS OF THE CORONA.
(EXPOSURE 16 SECONDS, WITH THE 40-FOOT CAMERA.)
CROCKER ECLIPSE EXPEDITION, THOMASTON, GEORGIA.

José and New Orleans. When the instruments were detained a week in New Orleans by the floods, and a dangerous delay was threatened, the kind offices of the Company were exerted to secure their shipment on the first train leaving the city for Atlanta.

Scarcely second in importance were the favors extended at every opportunity by the officials of the Central of Georgia Railway. We recall with pleasure the assistance afforded by President J. M. EGAN; by General Passenger Agent J. C. HAILE; by Col. D. W. APPLER, in charge of the company's interests in Atlanta; by Traveling Passenger Agent WARREN H. FOGG; and by Agent WHITE, at Thomaston.

The success of the expedition was promoted in every possible manner by the officials of the city of Thomaston, by the officials of Upson County and by the leading citizens. Hon. JAMES R. ATWATER, Mayor, made it a daily duty to inquire after our needs, and to supply them as far as possible, and promptly. Captain ATWATER'S constant thoughtfulness and helpfulness will not be forgotten. Among the special services rendered by the city, through its worthy Mayor, we may mention that excellent special watchmen were furnished for the camp, without expense to us. This service was executed in a satisfactory manner, and not even a nail was missing at the end of our five weeks' residence. City Marshal MCDANIEL assisted us very efficiently in many ways. The genial night-watchman, Mr. HAINSBERGER, was thoughtfully helpful on many occasions.

The Hon. R. D. SHUPTRINE, County School Commissioner; Dr. HERRING, County Trustee and citizen; and many other leading members of the community rendered services which will be gratefully remembered.

Professors MILLER and RUSSELL were constantly at the station during the three days preceding the eclipse, and were very efficient assistants in completing many of the minor mechanical details.

We desire to make special acknowledgment of the voluntary services rendered by Professor CURTIS. He was with us ten days. He assisted in the final installation of the instruments. He was placed in charge of the polar axis carrying the six cameras, and at the head of the observing party operating them. We do not see how we could have dispensed with his services, nor how any one could have met the exacting demands better than he did.

It may not be out of place to refer to the complex requirements of a successful eclipse expedition. The installation of a dozen instruments in a permanent observatory, with skilled and technical assistance available, so that all the instruments will work well when required, is not a simple matter. The dozen instruments at a temporary eclipse station, where skilled assistance is not available, must work equally well *at a given second of time.*

After our eclipse duties were over, we visited, with pleasure and profit, the most of the leading observatories of the country, and attended the annual meeting of the Astronomical and Astrophysical Society of America, in New York; returning to the Lick Observatory in the last week of July.

OBSERVATIONS OF THE ZODIACAL LIGHT FROM JANUARY, 1899, TO JULY, 1900.

By Francis J. Bayldon, R. N. R.

(abstract.)*

I. General Remarks.

All observations were made at sea. From January to August, 1899, our voyages were from Sydney to Wellington (N. Z.), Suva (Fiji Is.), Honolulu, Victoria (Vancouver Is.), and Vancouver (B. C.). Since August, 1899, the voyage is from Sydney to Brisbane (Queensland), Honolulu, Victoria, and Vancouver. The round voyage from Sydney to Sydney takes nine weeks, including two weeks' stay at Vancouver. In Sydney we remain for three weeks. If necessary, the average speed of the ship may be considered as fourteen knots per hour.

From January to August, 1899, the observations were chiefly made during my watch on deck from 8 to 12 P. M. aboard the R. M. S. *Aorangi.* From August to the present time they have been made from 7 to 9 P. M., and from midnight to 4 A. M. aboard the R. M. S. *Warrimoo.*

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*Mr. Bayldon's paper is too extensive to be printed in full in our *Publications.* With his consent, we therefore present this abstract, which gives in full the notes made on a few nights. The original paper is on file in the library of the Society.—The Committee on Publication.